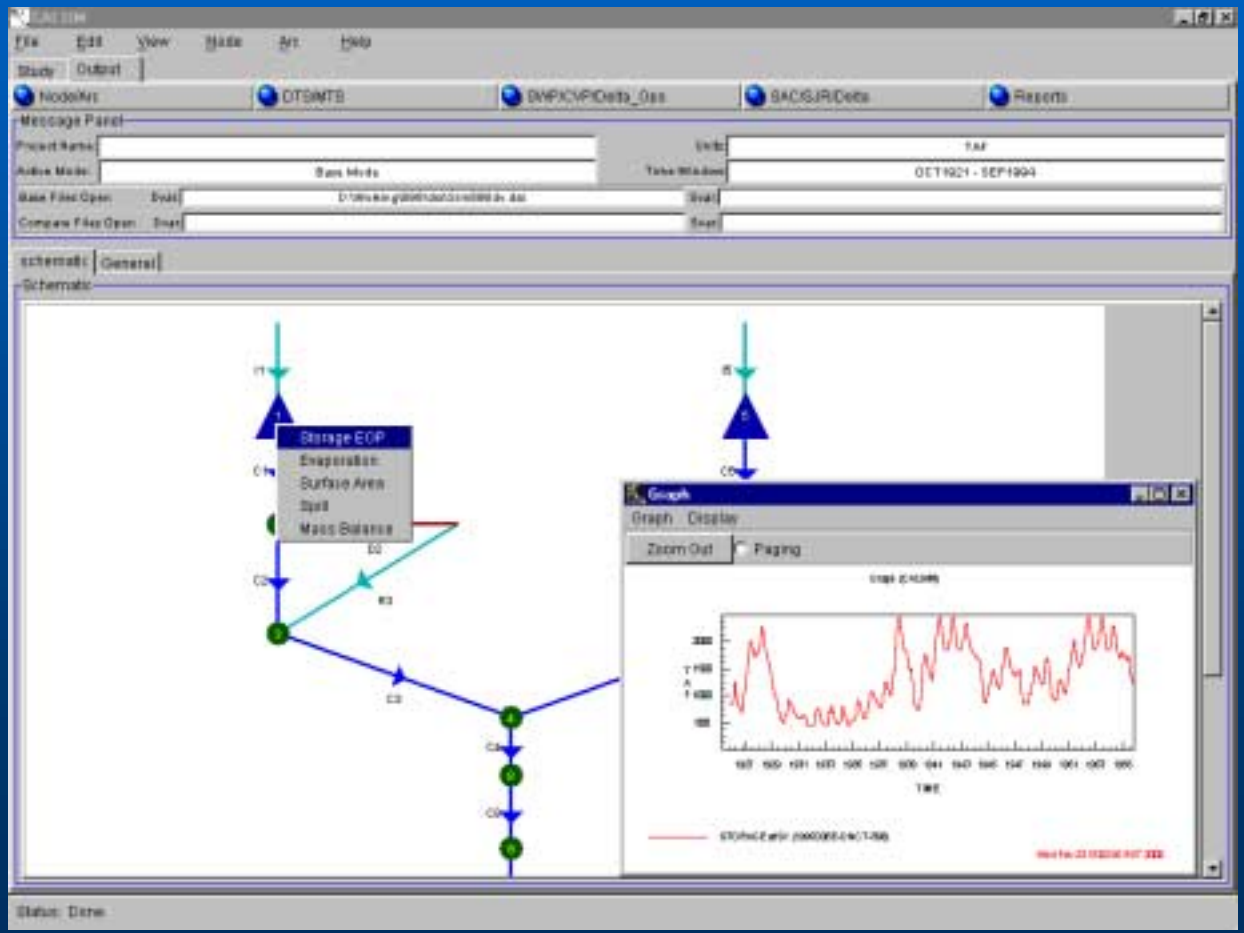
CALSIM Water Resources Simulation Model

Modeling Support Branch
http://modeling.water.ca.gov
Office of SWP Planning
Department of Water Resources

What is a Water Resources System Model ?

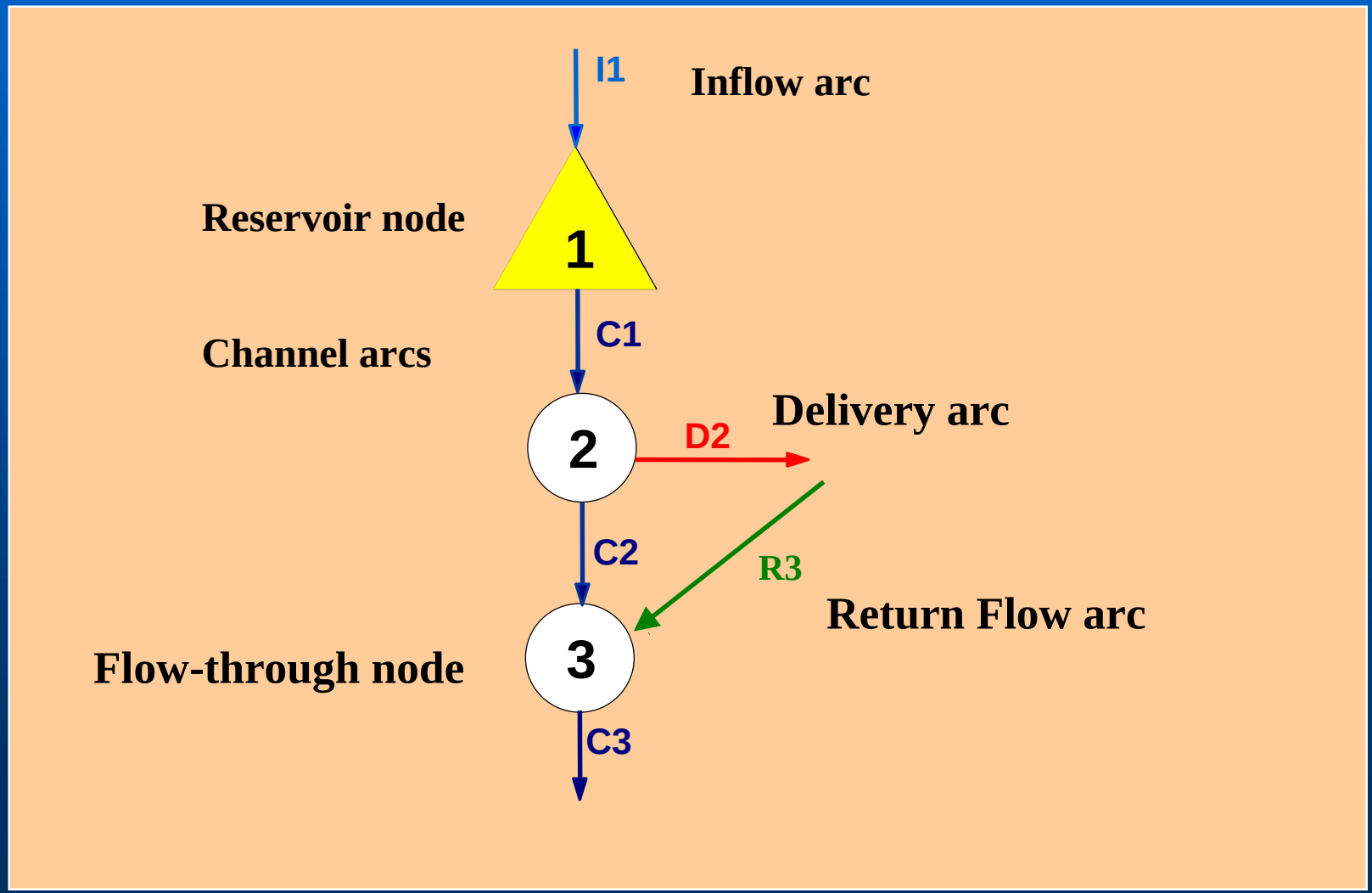
- Mathematical (numerical) representation of a real physical system (prototype)
- Represents relationships among the components of a real-world system.
- Used to evaluate the system response to a given hydrologic input, operational criteria and any proposed actions or facilities to evaluate “ what-if “ scenarios
- Necessarily a simplification of the system it describes. It would not be possible to construct a model that accounted for all the minute interactions of a complex system.

Model Description



- Water Resources Planning Model
- Network of nodes and arcs
- Graphical Interface
- LP solver for routing water
- WRESL language for specialized constraints
- Monthly/Daily timestep

System Representation



Role of CALSIM

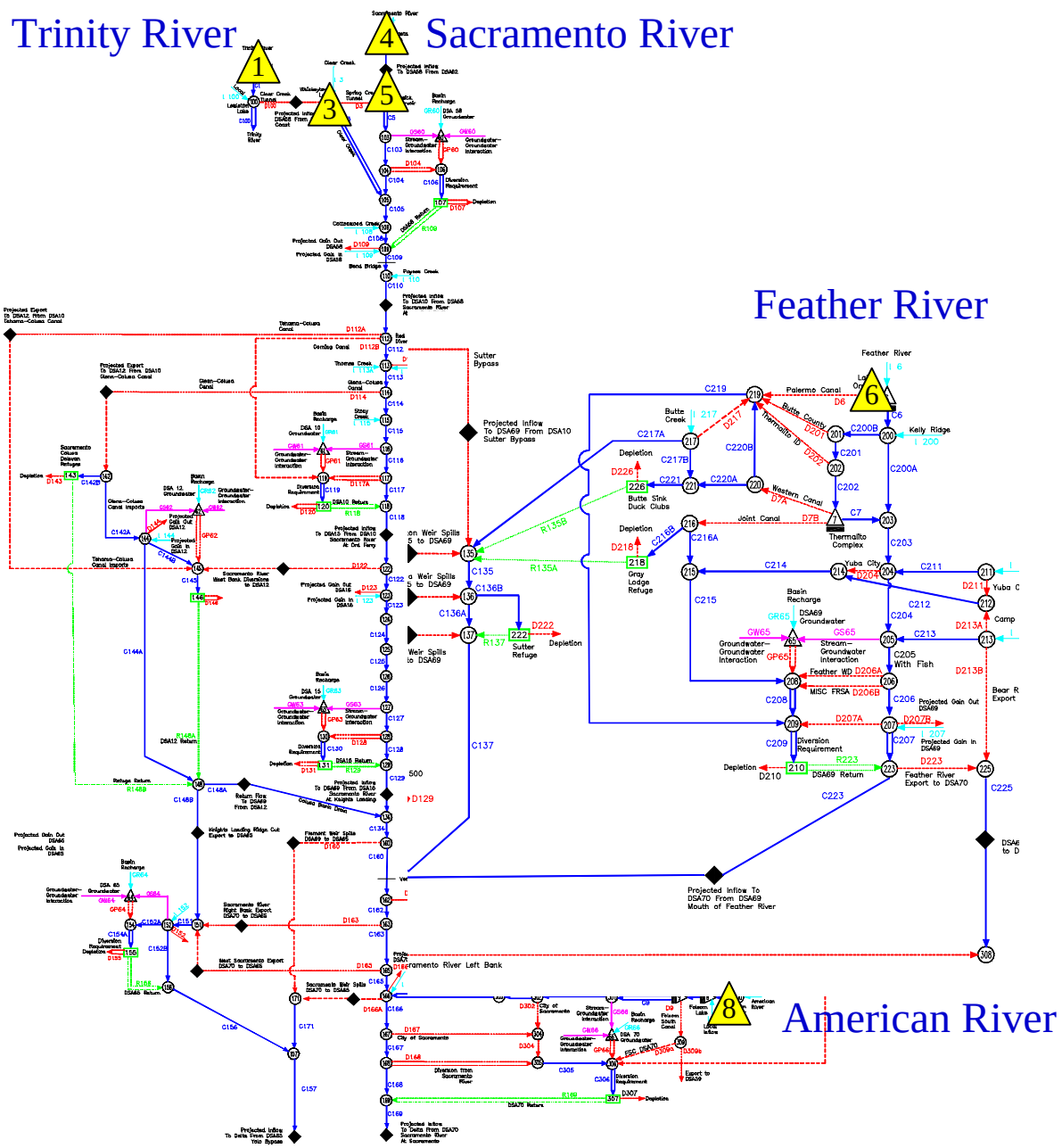
- Simulates Operations of SWP and CVP system facilities.
- Sacramento and San Joaquin River system and the Delta Operations.
- Accounts for system operational objectives, physical constraints, legal and institutional agreements and/or statutes.
- The model uses historical hydrological conditions, as modified, to reflect a given level of development.

Current CALSIM Applications

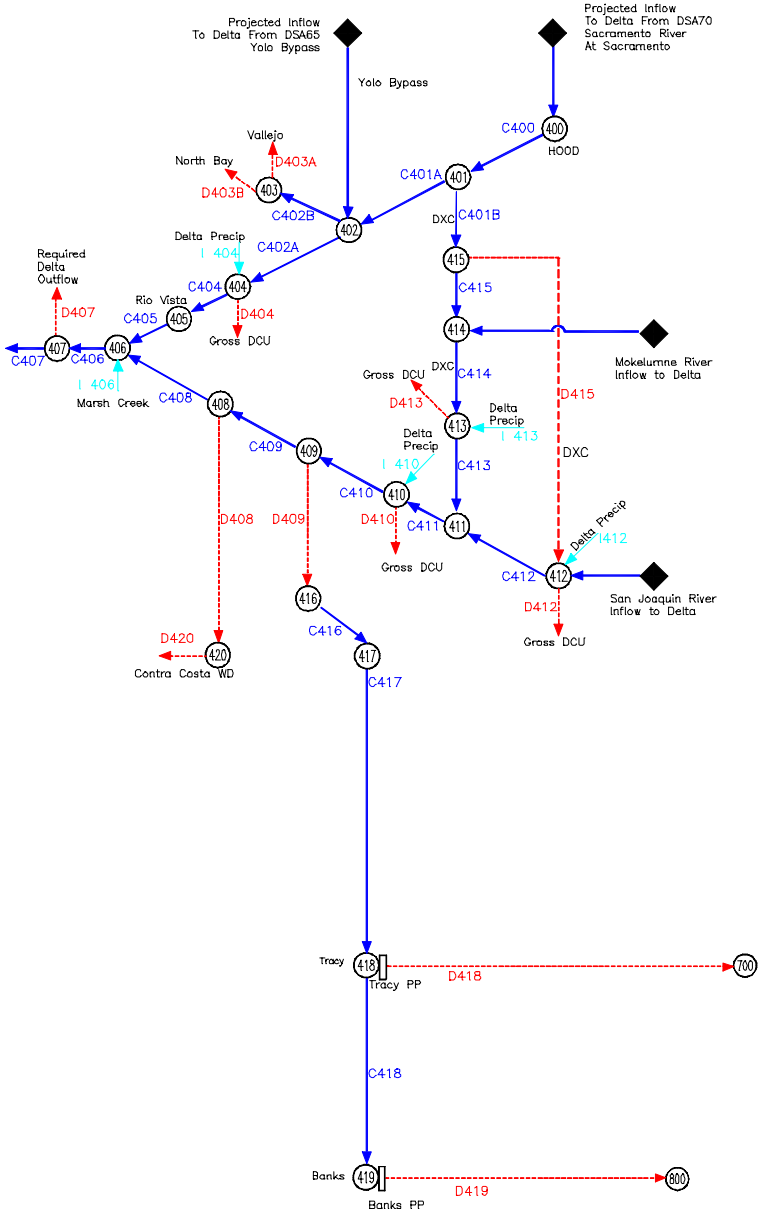
- CVP/SWP Water Supply Reliability Studies
- CALFED Bay-Delta Program
- CVPIA (b2) Evaluation
- SWRCB Water Rights Hearings Process
- CALFED ROD/EWA Operations
- Integrated Storage Investigations

Trinity
Shasta
Oroville
Folsom
State
Federal
San Luis Canal
California Aqueduct

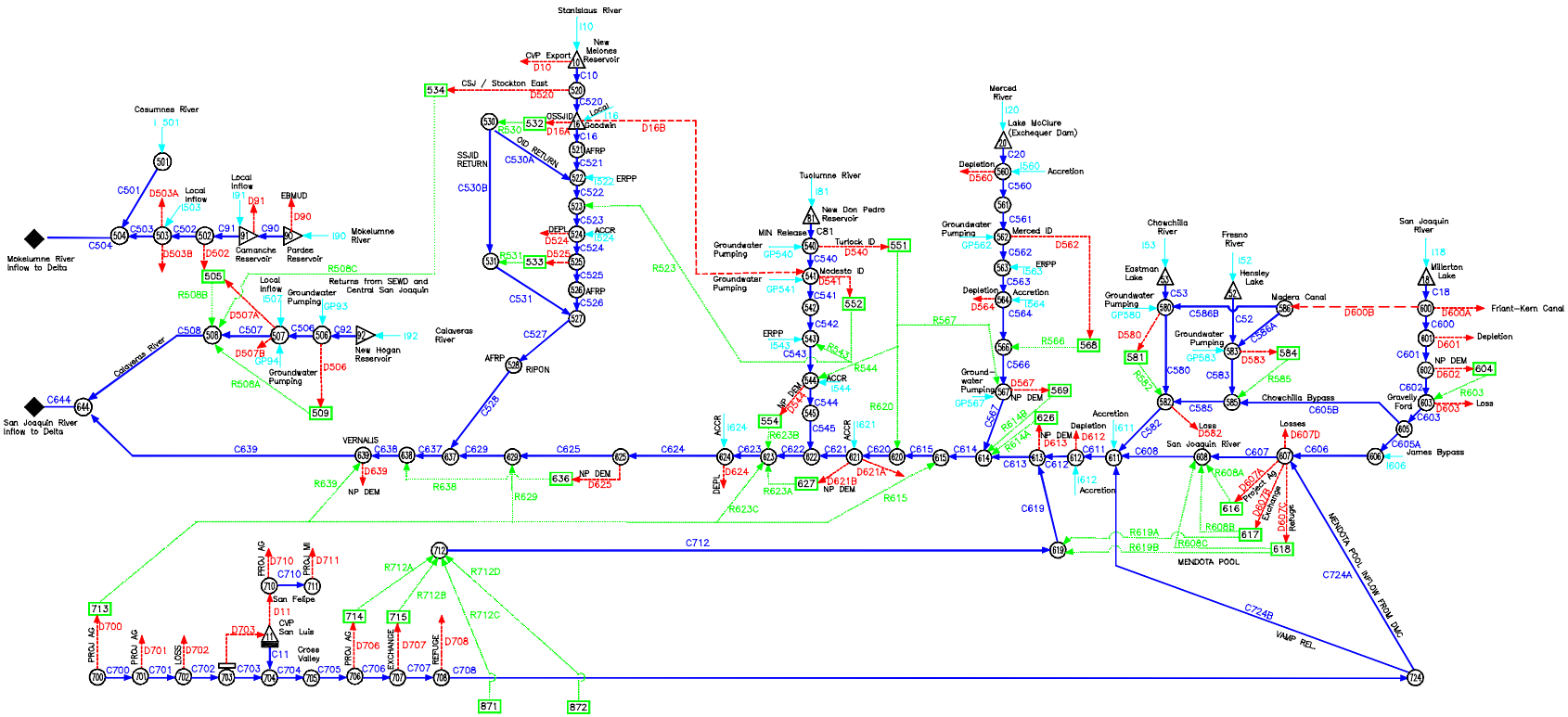
North


Trinity River
Sacramento River
Feather River
American River
Sutter Bypass
Projected Inflow To DSA69 From DSA10 Sutter Bypass
Projected Inflow To DSA70 From DSA69 Mouth of Feather River
Sutter Refuge
Gray Lodge Refuge
Butte Sink Duck Clubs
Thermalito Complex
Feather River Export to DSA70
Feather WD
MISC FRSA
With Fish
Yuba City
Palermo Canal
Western Canal
Joint Canal
Kelly Ridge
Butte Creek
Basin Recharge
Groundwater–Groundwater Interaction
Stream–Groundwater Interaction
Depletion
Diversion Requirement
DSA69 Groundwater
DSA69 Return
Projected Gain In DSA69
Projected Gain Out DSA69
Projected Gain Out DSA70
Projected Gain In DSA70
Refuge Return
DSA16 Return
DSA12 Return
Projected Gain Out DSA16
Projected Gain In DSA16
Projected Gain Out DSA12
Projected Gain In DSA12
Projected Export To DSA12 From DSA10 Tehama–Colusa Canal
Projected Export To DSA16 From DSA10 Glenn–Colusa Canal
Projected Inflow To DSA10 From DSA68 Sacramento River At
Projected Inflow To DSA70 From DSA68 Sacramento River At Knights Landing
Projected Inflow To Delta From DSA70 Sacramento River At Sacramento
Projected Inflow To Delta From DSA65 Yolo Bypass
Sacramento River Right Bank Export DSA70 to DSA68
Sacramento River Left Bank
West Sacramento Export DSA70 to DSA68
Sacramento River West Bank Diversions to DSA12
Weir Spills to DSA69
Weir Spills to DSA65
Fremont Weir Spills DSA69 to DSA65
Knights Landing Ridge Cut Export to DSA65
Projected Gain Out DSA65
Projected Gain In DSA65
Projected Gain Out DSA68
Projected Gain In DSA68
Projected Gain In DSA10
Projected Gain Out DSA10
Projected Gain In DSA18
Projected Gain Out DSA18
Tehama–Colusa Canal Imports
Glenn–Colusa Canal Imports
Sacramento Colusa Delevan Refuges
Tehama–Colusa Canal
Glenn–Colusa Canal
Cortina Creek
Cottonwood Creek
Clear Creek
Stony Creek
Thomes Creek
Willow Creek
Logging Creek
Spring Creek Tunnel
Whiskeytown Lake
Trinity River
Bend Bridge
Paynes Creek
Red Bluff
Dersing Canal
Basin Recharge
DSA 10 Groundwater
DSA 12 Groundwater
DSA 15 Groundwater
DSA 16 Groundwater
DSA 65 Groundwater
DSA 68 Groundwater
DSA 70 Groundwater
DSA 18 Groundwater
Stream–Groundwater Interaction
Groundwater–Groundwater Interaction
Diversion Requirement
DSA10 Return
DSA18 Return
Depletion
Refuge Return
Projected Gain Out DSA10
Projected Gain In DSA10
Projected Gain Out DSA18
Projected Gain In DSA18
Projected Gain Out DSA12
Projected Gain In DSA12
Projected Gain Out DSA16
Projected Gain In DSA16
Projected Gain Out DSA65
Projected Gain In DSA65
Projected Gain Out DSA68
Projected Gain In DSA68
Projected Gain Out DSA70
Projected Gain In DSA70
Projected Gain Out DSA69
Projected Gain In DSA69
Projected Gain Out DSA18
Projected Gain In DSA18
Projected Gain Out DSA16
Projected Gain In DSA16
Projected Gain Out DSA12
Projected Gain In DSA12
Projected Gain Out DSA10
Projected Gain In DSA10

Delta


Projected Inflow
To Delta From DSA65
Yolo Bypass
Yolo Bypass
Projected Inflow
To Delta From DSA70
Sacramento River
At Sacramento
C400
400
HOOD
Vallejo
North Bay
D403A
D403B
403
C401A
401
C402B
402
DXC
C401B
Delta Precip
I 404
C402A
415
Required
Delta
Outflow
C404
404
C415
Rio Vista
C405
406
D404
Gross DCU
D407
414
407
406
C407
C406
Mokelumne River
Inflow to Delta
I 406
Marsh Creek
C408
408
Gross DCU
DXC
C414
D413
D415
Delta
Precip
I 413
413
C409
409
Delta
Precip
I 410
DXC
C413
C410
410
D408
D409
D410
C411
411
Delta Precip
I 412
Gross DCU
C412
412
416
San Joaquin River
Inflow to Delta
D412
Gross DCU
D420
420
Contra Costa WD
C416
417
C417
Tracy
418
Tracy PP
D418
700
C418
Banks
419
Banks PP
D419
800

San Joaquin


Stanislaus River
I10
New Melones Reservoir
CVP Export
D10
C10
CSJ / Stockton East
D520
534
520
C520
Local
I16
OSSJID
D16A
D16B
Goodwin
C16
521
AFRP
C521
522
I522
ERPP
C522
523
C523
DEPL
D524
524
ACCR
I524
C524
D525
525
C525
526
AFRP
C526
527
RIPON
C527
SSJID RETURN
C530A
OID RETURN
C530B
530
532
R530
531
533
R531
C531
R523
Tuolumne River
I81
New Don Pedro Reservoir
MIN Release
C81
Groundwater Pumping
GP540
540
C540
Turlock ID
D540
551
Modesto ID
D541
541
C541
542
552
C542
ERPP
I543
543
C543
R543
R544
ACCR
I544
544
C544
NP DEM
D554
554
545
C545
ACCR
I621
R620
R567
Merced River
I20
Lake McClure (Exchequer Dam)
20
C20
Depletion
D560
560
I560
Accretion
C560
561
C561
Groundwater Pumping
GP562
562
Merced ID
D562
C562
563
ERPP
I563
C563
Depletion
D564
564
Accretion
I564
C564
566
R566
568
C566
Ground-water Pumping
GP567
567
NP DEM
D567
569
C567
R614B
R614A
626
Depletion
D613
NP DEM
D612
Accretion
I611
C611
C612
C613
C614
C615
C620
C621
C622
C623
C624
R623B
R623A
R623C
627
NP DEM
D621B
D621A
DEPL
D624
ACCR
I624
554
R615
R619A
R619B
R608C
MENDOTA POOL
C619
619
C712
712
R712A
R712B
R712C
R712D
714
715
871
872
C724A
C724B
VAMP REL.
MENDOTA POOL INFLOW FROM DMC
724
Calaveras River
I92
New Hogan Reservoir
Local Inflow
I91
D91
EBMUD
D90
Mokelumne River
I90
Camanche Reservoir
Pardee Reservoir
C90
C91
C92
90
91
92
Groundwater Pumping
GP93
I507
D507A
D507B
GP94
D506
R508A
R508B
R508C
Returns from SEWD and Central San Joaquin
Mokelumne River Inflow to Delta
C504
504
C501
D503A
I503
C503
503
C502
502
D502
D503B
505
509
C508
508
C507
507
C506
506
C644
644
San Joaquin River Inflow to Delta
Calaveras River
C639
639
VERNALUS
C638
638
C637
637
C629
629
C625
625
636
NP DEM
D625
D639
NP DEM
R639
R638
R629
C528
Cosumnes River
I 501
501
C501
D503A
Local Inflow
I503
C503
503
C502
502
D502
D503B
C504
504
Mokelumne River Inflow to Delta
R508B
R508C
505
Local Inflow
I507
D507A
D507B
GP94
Groundwater Pumping
GP93
C508
508
C507
507
C506
506
C92
92
New Hogan Reservoir
I92
Calaveras River
D506
509
R508A
C644
644
San Joaquin River Inflow to Delta
C639
639
VERNALUS
C638
638
C637
637
C629
629
C625
625
636
NP DEM
D625
D639
NP DEM
R639
R638
R629
C528
713
PROJ AG
D700
700
C700
PROJ AG
D701
701
C701
LOSS
D702
702
C702
703
C703
D703
San Felipe
D11
CVP San Luis
C11
Cross Valley
704
C704
705
C705
PROJ AG
D706
706
EXCHANGE
D707
707
C707
REFUGE
D708
708
C708
C710
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PROJ AG
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PROJ MI
D711
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R712A
R712B
R712C
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C712
C724A
C724B
VAMP REL.
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C20
Depletion
D560
560
I560
Accretion
C560
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C561
Groundwater Pumping
GP562
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Merced ID
D562
C562
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ERPP
I563
C563
Depletion
D564
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Accretion
I564
C564
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R566
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C566
Ground-water Pumping
GP567
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NP DEM
D567
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C567
R614B
R614A
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Depletion
D613
NP DEM
D612
Accretion
I611
C611
C612
C613
C614
C615
C620
C621
C622
C623
C624
R623B
R623A
R623C
627
NP DEM
D621B
D621A
DEPL
D624
ACCR
I624
554
R615
R619A
R619B
R608C
MENDOTA POOL
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ACCR
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AFRP
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RIPON
C527
SSJID RETURN
C530A
OID RETURN
C530B
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532
R530
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533
R531
C531
R523
Chowchilla River
I53
Eastman Lake
53
Fresno River
I52
Hensley Lake
52
San Joaquin River
I18
Millerton Lake
18
C18
Groundwater Pumping
GP580
580
C53
C586B
C52
C586A
Madera Canal
586
D600B
600
D600A
Friant-Kern Canal
D580
581
C580
Groundwater Pumping
GP583
583
D583
584
C583
R582
R585
582
C585
585
Chowchilla Bypass
C605B
Loss
D582
Losses
D607D
D607A
Project Ag
D607B
Recharge
D607C
Recharge
C582
Accretion
I611
C611
C612
C613
C614
C615
C620
C621
C622
C623
C624
R623B
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R608C
MENDOTA POOL
C619
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R567
C608
608
San Joaquin River
C607
607
C606
606
James Bypass
C605A
I606
R608A
R608B
616
617
618
C724A
C724B
VAMP REL.
MENDOTA POOL INFLOW FROM DMC
724
600
D600A
Friant-Kern Canal
C600
601
D601
Depletion
C601
NP DEM
602
D602
604
C602
Gravelly Ford
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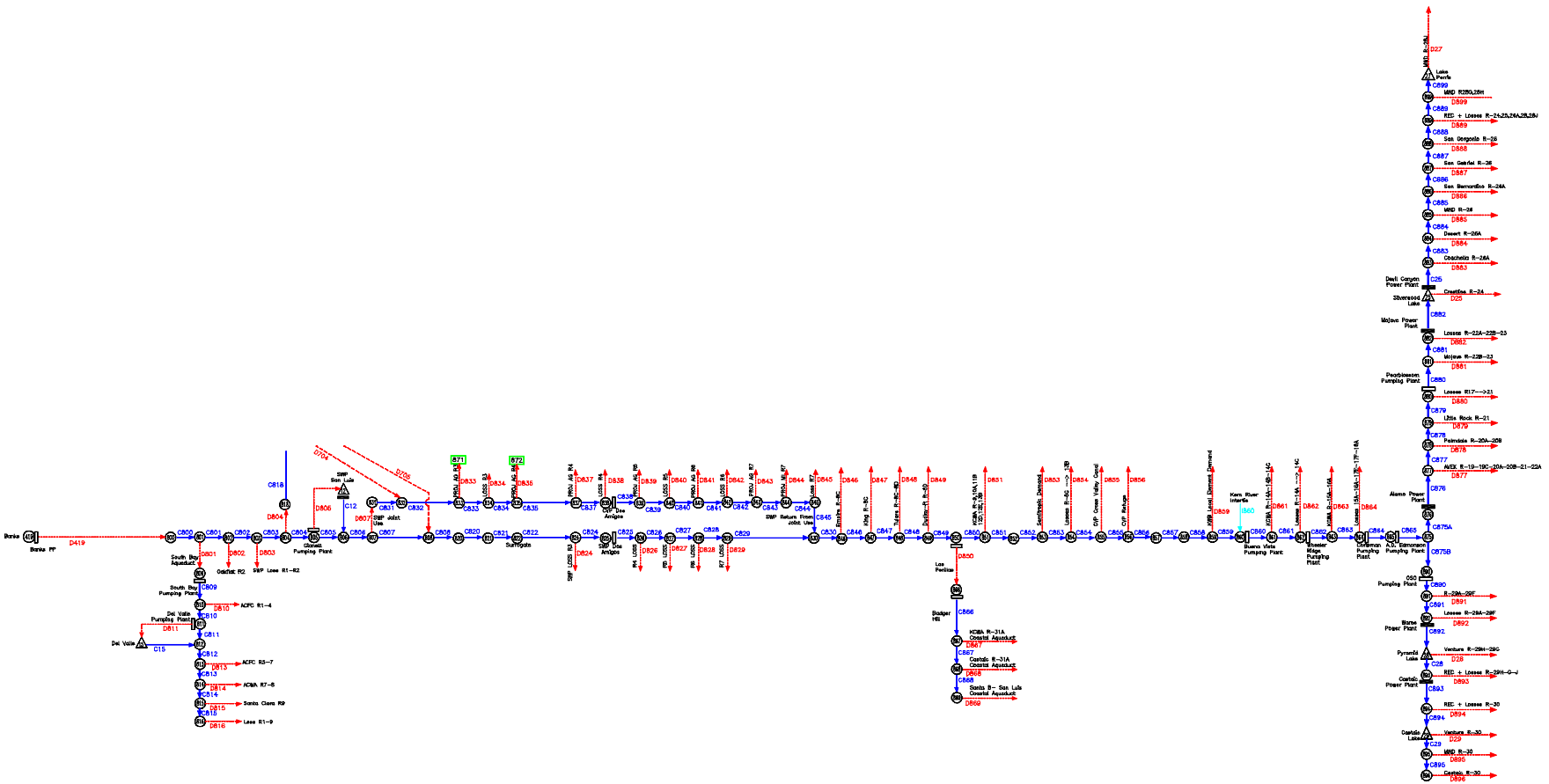
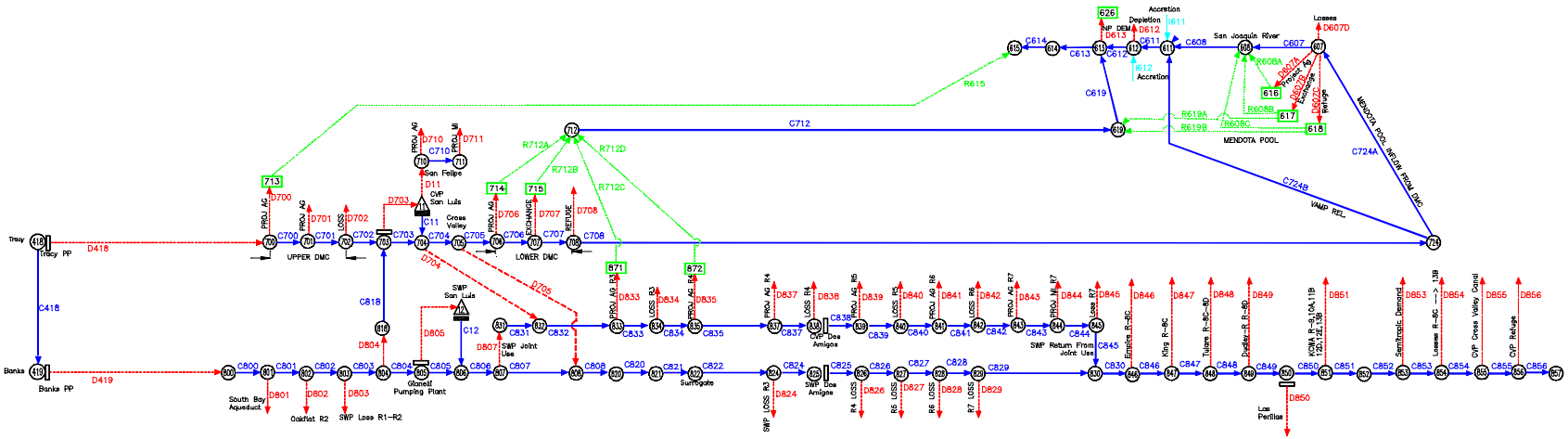
D603
Loss
C603
R603
605
C605A
James Bypass
I606
606

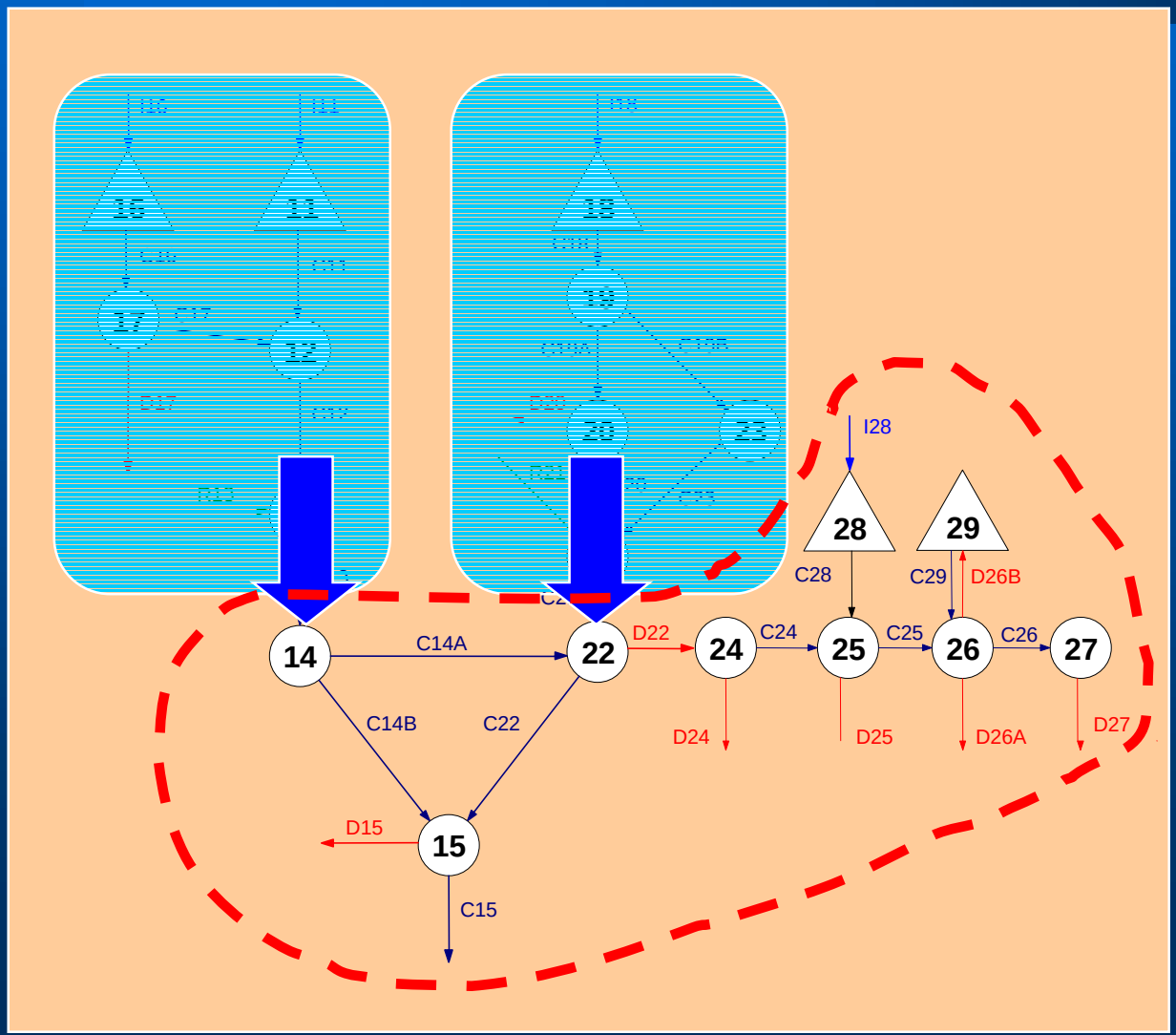
SWP South of Delta



CVP South of Delta



Subsystem Isolation and Testing



Isolate component of interest by “cutting” free-body diagram

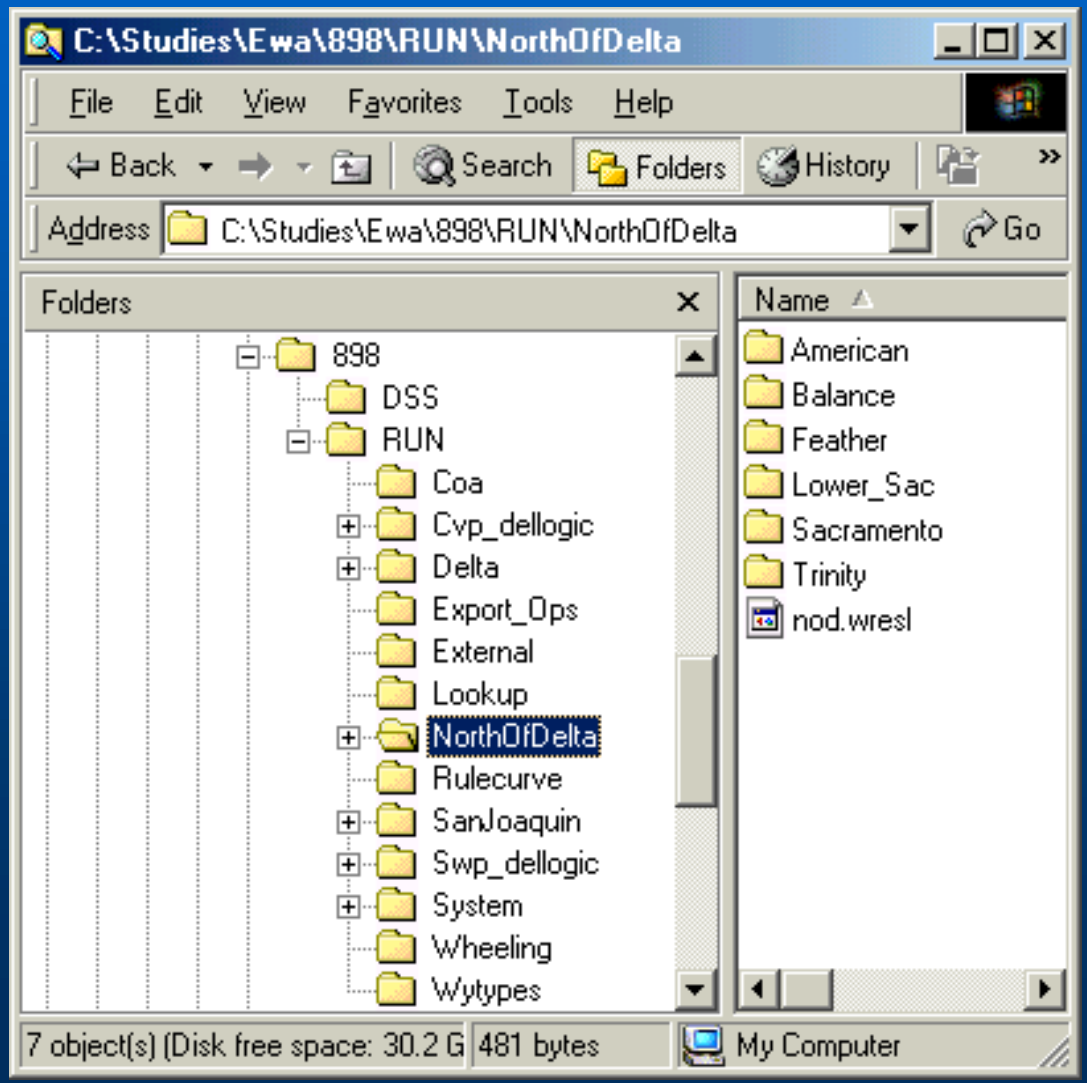
Fix flows, deliveries, or storages from other components to desired values

Test operation of isolated system in detail

CALSIM Highlights

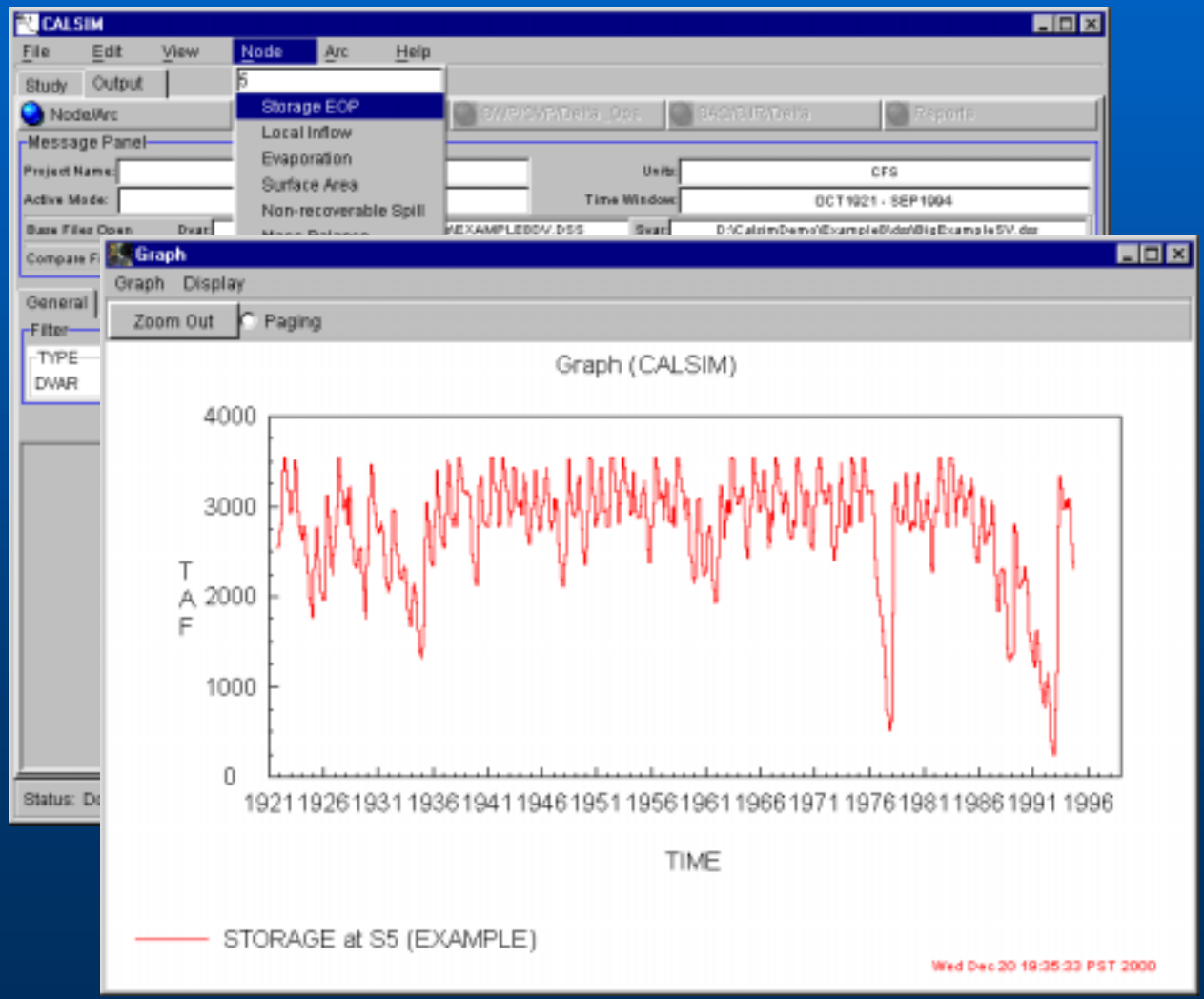
- Input-driven model
- Ease of changing rules/operations
- Modular
- Interactive - Computer Aided Negotiations (CAN)

Modular Input Structure

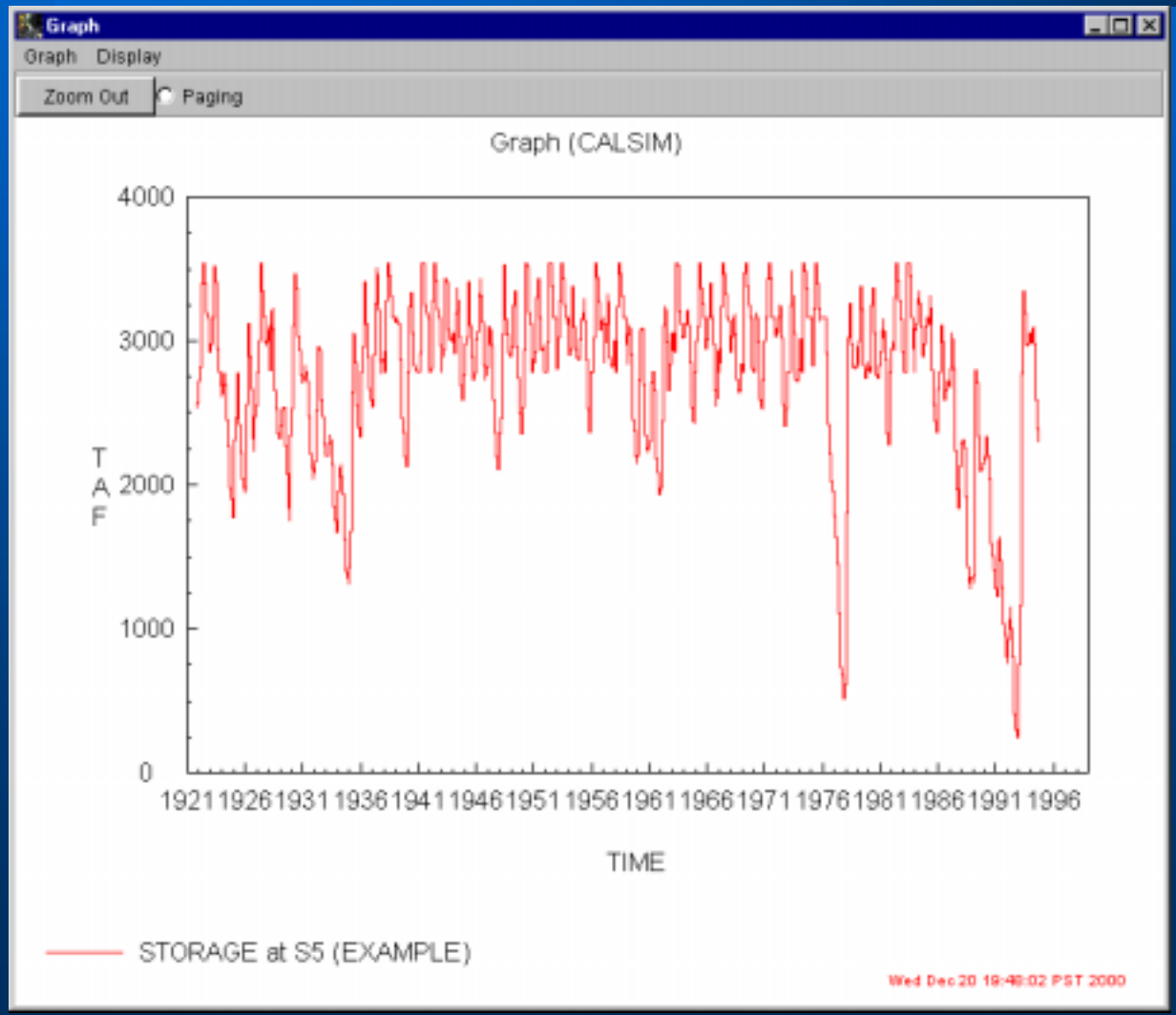


- **Organization of similar rules in same folders**
- **Separation of time-series and relational data**
- **Separation of external modules**

User Interface: Input/Output Analysis



Sample
Graphical & Tabular Display



/CALSIM/S5/STORAGE/01JAN192...

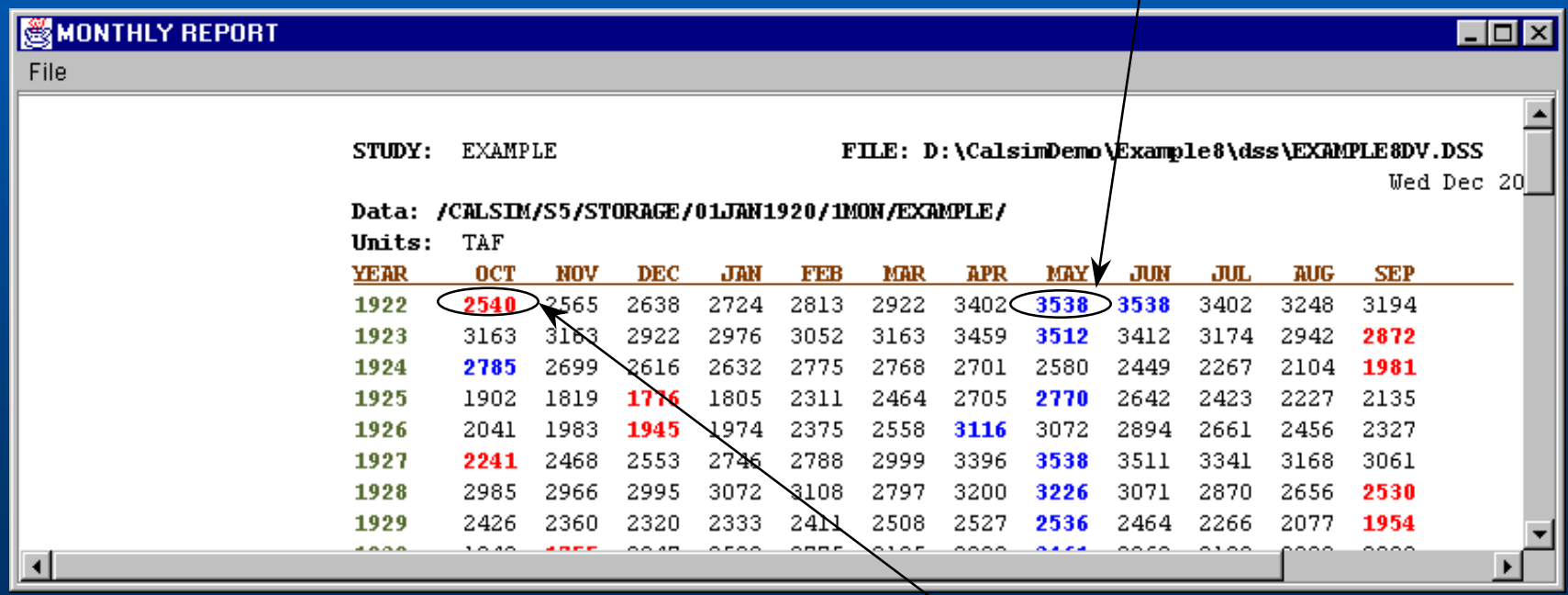
Data

local
D:\CalsimDemo\Example8\dss\EXAMPLE8DV.DSS
/CALSIM/S5/STORAGE/01JAN1920/1MON/EXAMPLE/
Number of data points: 876
31OCT1921 2400 - 30SEP1994 2400

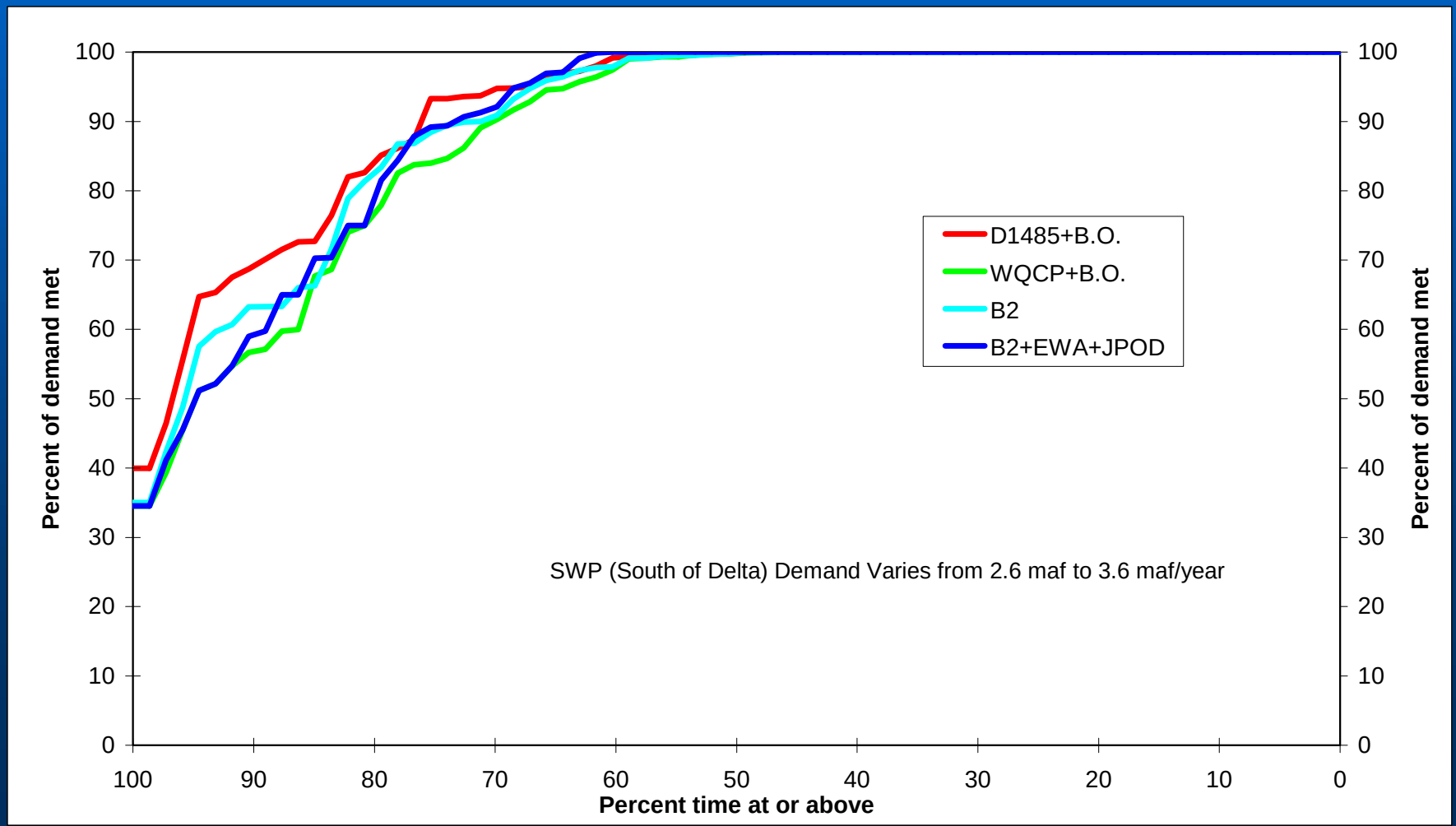
Time	Value
31OCT1921 2400	2539.627
30NOV1921 2400	2564.520
31DEC1921 2400	2637.593
31JAN1922 2400	2723.812
28FEB1922 2400	2813
31MAR1922 2400	2922
30APR1922 2400	3401.819
31MAY1922 2400	3538
30JUN1922 2400	3538
31JUL1922 2400	3402.135
31AUG1922 2400	3247.573
30SEP1922 2400	3193.864
31OCT1922 2400	3163
30NOV1922 2400	3163
31DEC1922 2400	2922
31JAN1923 2400	2976
28FEB1923 2400	3051.703
31MAR1923 2400	3163
30APR1923 2400	3459
31MAY1923 2400	3511.719
30JUN1923 2400	3412.234
31JUL1923 2400	3174.286
31AUG1923 2400	2941.812
30SEP1923 2400	2871.842
31OCT1923 2400	2785.135
30NOV1923 2400	2698.553
31DEC1923 2400	2616.07
31JAN1924 2400	2631.636
29FEB1924 2400	2774.736
31MAR1924 2400	2767.888
30APR1924 2400	2701.045

Goto row:

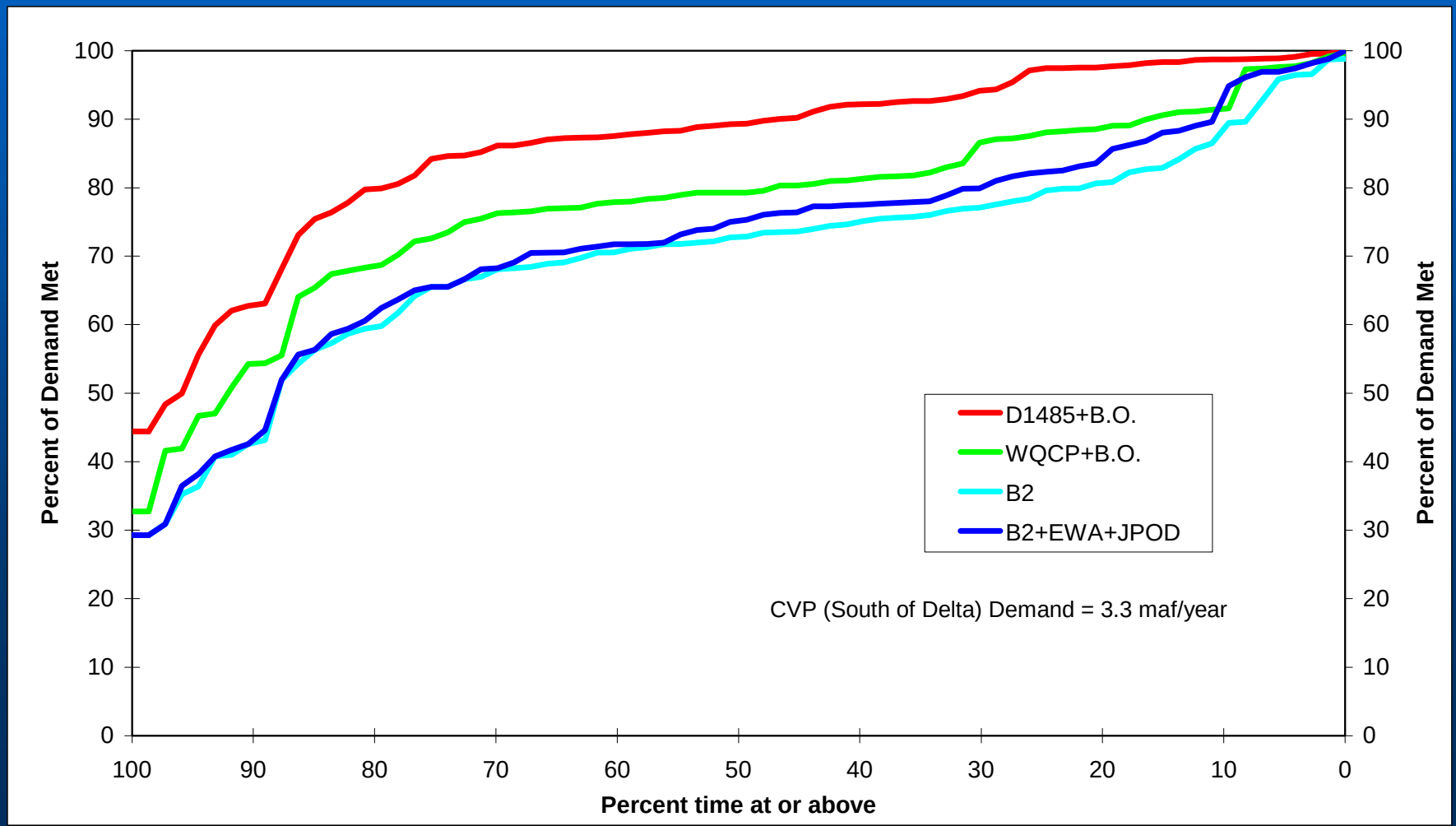
Sample
Monthly Table display



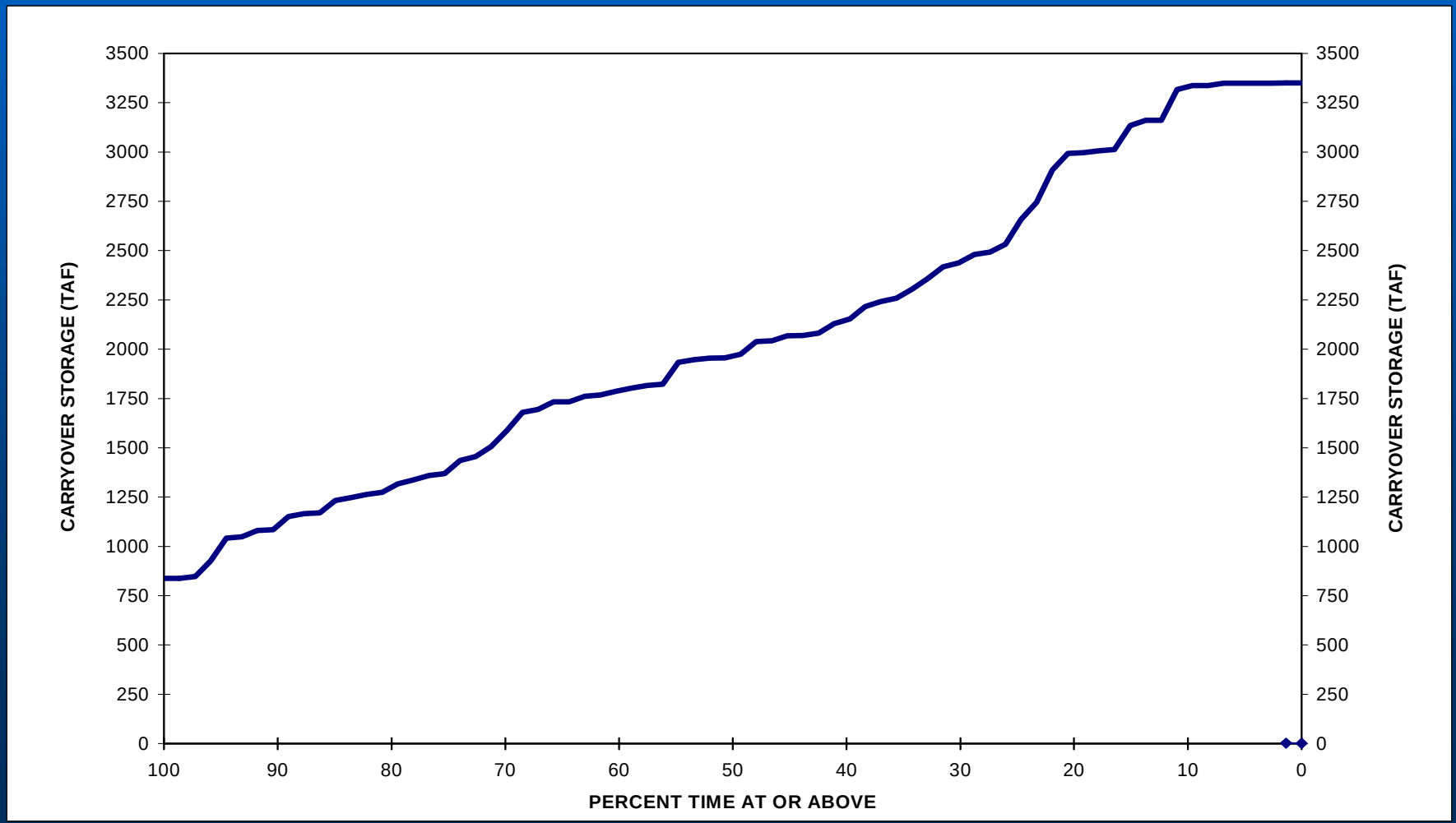
Sample
SWP Delivery Reliability



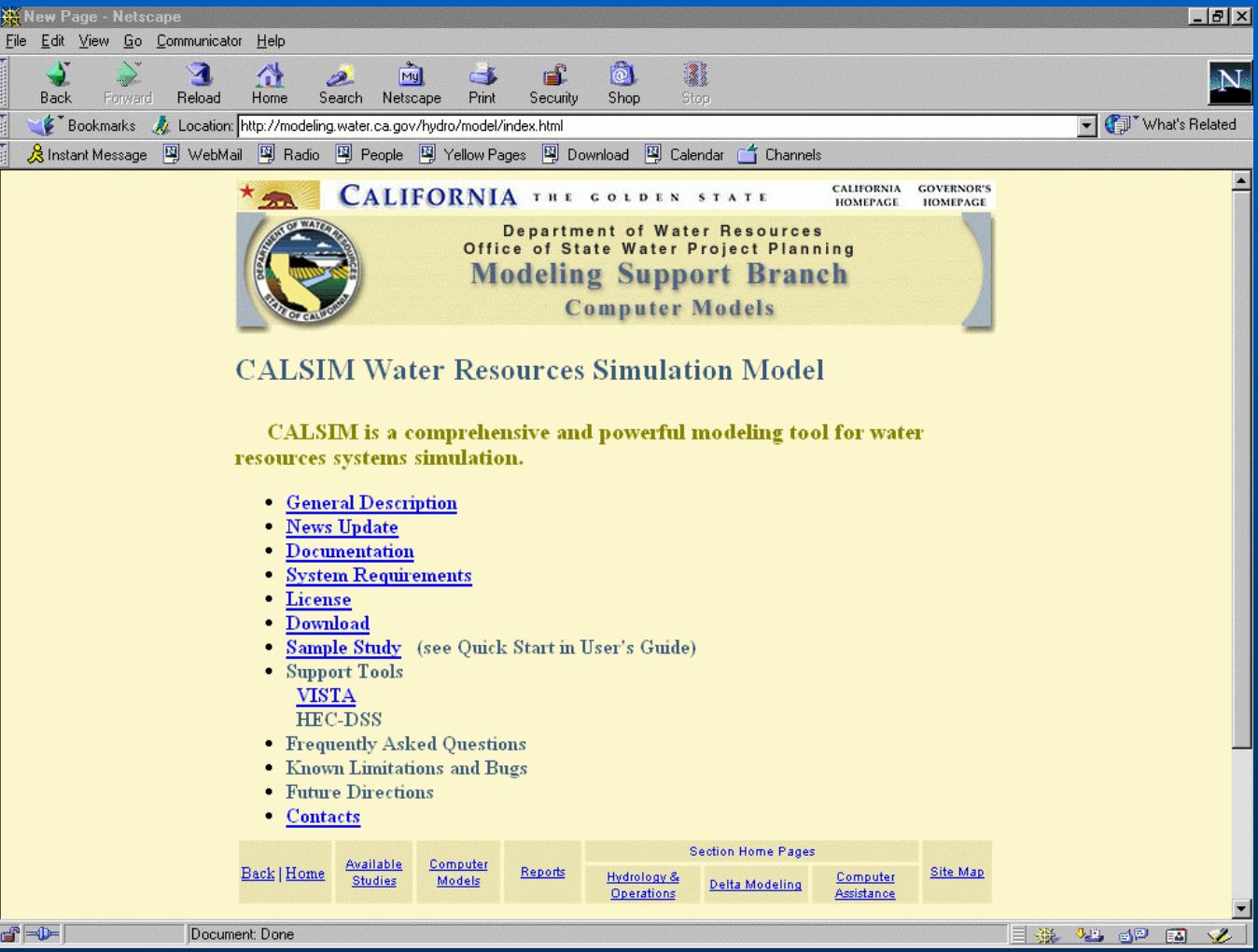
Sample
CVP Delivery Reliability



Sample
Oroville End of September Storage



CALSIM Homepage
http://modeling.water.ca.gov



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